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# STUDY OF THE CHEMICAL AND MINERAL COMPOSITION OF COMPLEX FERTILIZER

## Abstract

This article shows that the use of technogenic waste as raw materials in the production of complex fertilizers not only improves the environmental situation of the region, but also allows you to create economically efficient production. In the non-ferrous metallurgy industries of our country, hundreds of millions of tons of industrial waste containing elements such as copper, zinc, magnesium, nickel, manganese, etc. have accumulated in the form of slag, sludge, etc. Every year, more than ten thousand tons of waste are added to these wastes. In this regard, research has been carried out on the processing of industrial waste.

**Keywords:** industrial waste, waste processing, Metallurgical slags, mineralogical composition, chemical reclamation, slag reclamation agents, chemical composition.

## Introduction

The technological method and values of indicators for adding metallurgical slags to fertilizers are based on the features and special properties of metallurgical slags processing. The processes of adding metallurgical slag to ammophoska fertilizer obtained in laboratory conditions were studied. During the addition of microelements to the composition of fertilizers, various compound formation processes occur. Salts of microelements form several compounds with phosphate ions: $Me_3(PO_4)2{\cdot}nH_2O$; $MePO_4{\cdot}nH_2O$; $Me(H_2PO_4){\cdot}nH_2O$; $MeNPO_4{\cdot}nH_2O$, and these compounds have different solubility. It was found that in the $CuO$-$H_3PO_4$-$H_2O$ system at 250C there are three different phosphoric acid salts of copper. At $Cu_3(PO_4)_2{\cdot}3H_2O$, 20-57% $P_2O_5$ crystallizes, at 20-57% $P_2O_5$, $CuHPO_4{\cdot}H_2O$ crystallizes, and at higher concentrations, $Cu(H_2PO_4)_2$ crystallizes.

## Materials and Methods

To determine the chemical and mineral composition of the ammophoska obtained in the experimental conditions, X-ray, IR spectroscopic and differential thermal analyses were carried out.

X-ray phase analysis of the product (Figure 6) was performed on a DRON-5 diffractometer at a voltage of 25 kV, a current of 8 mA, and a counter speed of 2 degrees per minute. We determined the ratio of diffraction lines based on the interplanar spacing values and intensities of phosphate, calcite, α - quartz, and crystal hydrates[1,2]. These diffraction lines Ao 3.43; 3.16; 2.79; 2.71; 1.936; 1.877; 1.837; 1.780 correspond to iron salts, and Ao 3.03; 2.29; 1.908 interplanar spacings indicate the presence of calcium salts in the product. The diffraction line Ao3.32 showed that it lies in quartz.

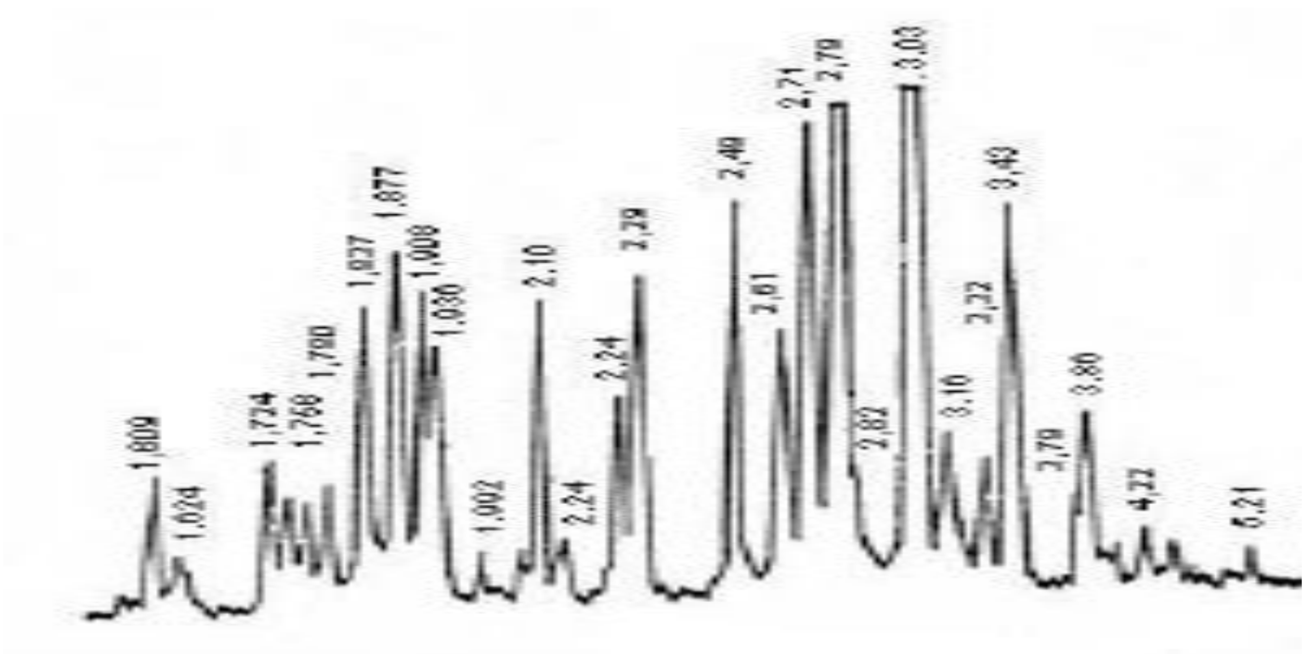


Figure 1. X-ray of the Ammofoska product

**Results and Discussion**

Identification of the mineral composition of the phosphate product was carried out by IR spectroscopy. IR spectra were carried out on a UR-20 device in the frequency range of 400-4000 cm-1. (Fig. 2). The samples were prepared by compaction of KVr. In the IR spectra of phosphate, absorption lines of antisymmetric valence and deformation motion of the RO4 ion are observed. The reduction of the correct tetrahedral symmetry of the RO4 ion to CO2 leads to its decomposition in the region of 566-600 cm-1 and 1026-1066 cm-1. [3-5]. The frequencies of motion in the phosphate spectrum are 880; 1430 cm-1 belonging to calcium salts. The displacement of the RO4 ion in the phosphate molecule to the CO2 group can be explained by the shift of the maximum of the motion lines to the high-frequency region, which is accompanied by the occurrence of absorption lines characteristic of carbonates in the phosphate mineral. The weak and medium intensities at 2500 and 3320 cm-1 belong to crystalline water.

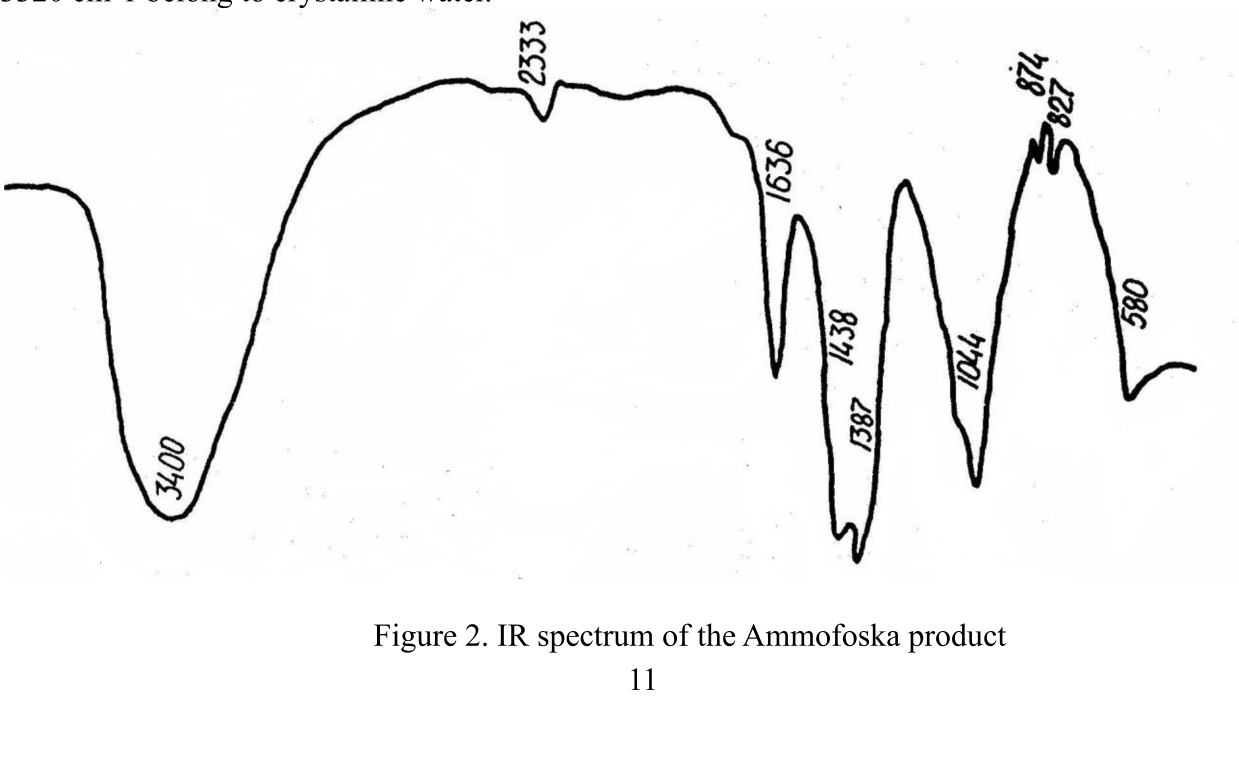


Figure 2. IR spectrum of the Ammofoska product

To obtain more detailed information about the composition and structure of individual components of phosphate fertilizer, solid-phase scanning electron microscopy (SEM) studies were conducted [6,7]. The analysis of electron microscopy studies showed that 12 chemical elements (O, Na, K, Mg, Al, Si, P, S, Ca, Fe, F, N) are present in the sample in different quantitative ratios. The amount of elements (Na, K, Mg), which make up the water-soluble part of phosphates, is significantly higher. The amount of sulfur in the form of sulfate is 2.24%. The amount of phosphorus, the main component, is from 9.04% (min) to 14.23% (max). This means 20.7% of the amount of P2O5. The amount of calcium is 8.37%, and aluminum is 8.68%. The amount of silicon is 46.85% (max). It is known that silicon is found only in natural minerals in the form of silicates. Therefore, it can be concluded that the presence of Si+4 ions in the sample occurs in the form of octahedral structural ions of silicon [$SiO_6$].

By means of the compositional-structural analysis of the SEM spectral results, we have confirmed that the components of phosphate fertilizer have natural features that are sensitive to changes in the pH of the environment. It was found that the phosphate components in the product are sensitive to hydrogen H+ ions.

The mineral composition and microstructure of the ammophoska obtained from the experiment, which contains industrial waste, shows the required amount of phosphorus, nitrogen, magnesium, potassium, and calcium. This, in turn, indicates the effectiveness of processing industrial waste to produce resource-saving fertilizers.

**Conclusions**

The raw materials required for the production of ammophoska are described. The process of obtaining ammophoska by neutralizing phosphoric acid of known concentration with ammonia water in two stages was studied in laboratory conditions. The results of experimental tests conducted on the production of complex fertilizer were compared with standard indicators.

To ensure the accuracy of the studied data, studies were conducted to determine the reactions of neutralization of phosphoric acid, i.e. the decomposition of phosphoric acid, and the main technological indicators of the process. In addition, ways of processing industrial waste slag were considered, and a scheme for obtaining fertilizers containing trace elements was proposed. The quality of the obtained complex fertilizer product was determined using modern methods of physicochemical analysis and crystal-optical analysis.

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## КҮРДЕЛІ ТЫҢАЙТҚЫШТЫҢ ХИМИЯЛЫҚ ЖӘНЕ МИНЕРАЛДЫ ҚҰРАМЫН ЗЕРТТЕУ

**Түйін**

Бұл мақалада техногенді қалдықтарды кешенді тыңайтқыштар өндірісінде шикізат ретінде қолдану аймақтың экологиялық жағдайын жақсартумен қатар, экономикалық тиімді өндіріс құруға мүмкіндік беретіндігі туралы көрсетілген. Еліміздің түсті металлургия өндірістерінде жүздеген миллион тонна мыс, мырыш, магний, никель, марганец, және т.б. элементтері бар өндіріс қалдықтары ретінде шлак, шлам және т.б. жинақталып қалған. Жыл сайын бұл қалдықтарға он мыңнан астам тонна қалдықтар қосылып жатыр. Осыған байланысты өндіріс қалдықтарын өңдеу бойынша зерттеу жұмыстары жүргізілді.

**Кілттік сөздер:** өндірістік қалдықтар, қалдықтарды қайта өңдеу, Металлургиялық қождар, минералогиялық құрам, химиялық мелиорация, қожды мелиорациялау агенттері, химиялық құрам.

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## ИЗУЧЕНИЕ ХИМИЧЕСКОГО И МИНЕРАЛЬНОГО СОСТАВА КОМПЛЕКСНОГО УДОБРЕНИЯ

**Аннотация**

В данной статье показано, что использование техногенных отходов в качестве сырья при производстве комплексных удобрений не только улучшает экологическую ситуацию в регионе, но и позволяет создать экономически эффективное производство. В цветной металлургии нашей страны скопились сотни миллионов тонн промышленных отходов, содержащих такие элементы, как медь, цинк, магний, никель, марганец и др., в виде шлака, осадка и т. д. Ежегодно к этим отходам добавляется более десяти тысяч тонн. В связи с этим были проведены исследования по переработке промышленных отходов.

**Ключевые слова:** промышленные отходы, переработка отходов, металлургические шлаки, минералогический состав, химическая утилизация, шлакореактиваторы, химический состав.